THE COB-ROT OF CORN

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Agricultural Experiment Station

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[3]In cooperation with Bureau of Plant Industry, U. S. Department of Agriculture.
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[1]With leave of absence. [2]In cooperation with Weather Service, U. S. Department of Agriculture.

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THE COB-ROT OF CORN*

By E. G. ARZBERGER

INTRODUCTION

The fungus organism which, in part, initiated the work on this problem was first sent to the Experiment Station by W. J. Wheeler, of Paulding, Ohio, April 12, 1911. He had noted that the cob tissue of some of his stored seed corn, crop of 1910, had become somewhat abnormal; this was partly due to the activity of a fungus which was subsequently identified as belonging to the genus *Coniosporium*.

Some preliminary observations were made on this fungus during the year after it was found. During the fall and winter of 1911-12 the fungus again appeared abundantly on the husked corn. In April, 1912, more extensive observations and investigations were begun, the details of which are set forth in this report.

The chief object of this investigation was to determine whether the fungus in question, *Coniosporium Gecevi* Bubak, found on the ears of field corn is a true parasite or only a saprophyte.

The literature regarding this fungus is not very extensive, and the greater part of it consists of mere mycological descriptions. Saccardo, including those in his 17th volume, has described 82 species of Coniosporium. Some of the descriptions are detailed enough and state whether the species are parasitic or saprophytic, while others are recorded rather incompletely. The nature of the greater number can be judged from the dead or decaying wood or plant tissue upon which the fungus had been found.

Of the 82 species given, 57 are saprophytic, 10 parasitic and 15 are questionable, regarding their nature. These may be saprophytes or facilitative parasites.

*In the fall of 1911 there was prevalent over Ohio a disease or affection of corn which had not previously been observed on so large a scale. The trouble was manifested in a softening and decay of the cob, rendering the grain unmerchantable. The outbreak was so general that great anxiety was felt lest a serious disease of this most important cereal had made its appearance, and in response to request of leading grain dealers and others an emergency appropriation was authorized by the Emergency Board for the study of the outbreak by the Botanical Department of the Experiment Station. This work was assigned by the Station Botanist to Mr. E. G. Arzberger, Assistant Botanist, an abstract of whose report upon it is given in the following pages. A. D. Selby, Botanist.

Lindau, in Rabenhorst's Kryptogamic Flora, describes 40 species, of which 37 are obligate saprophytes, and 3 are parasitic; some of these are questionable, however, regarding their parasitic nature. One species described may be classed as a facilitative parasite.

Jaap and Bubak haxe recently described three other species of Coniosporium, all of which are saprophytic. The greater number of the above have been found in Europe. Spegazzini, in his list of Mycetes Argentinensis of South America, reports four new species, all of which are saprophytic.

If access could be had to the proper herbarium material, it would probably be found that *Coniosporium Gecevi*, described in 1911, had already been described as some other form in America. However, from the most authentic mycological descriptions one may note the general saprophytic nature of this genus. In Rabenhorst's Kryptogamic Flora, Lindau makes this general statement about the entire genus: "The development of this fungus, especially the nature and formation of the conidia, is still unknown, and requires elucidation through cultural examinations. The *greatest number live* as *obligate saprophytes*, yet not without exception, as is shown in *Coniosporium arundis*, which, in its mycelial stage, is found in the living tissue of its host plant."

Bubak,[1] of Tabor, Bohemia, describes in Centrb. f. Bak. u. Infekk. 31: 500-502, 1911, a new species of Coniosporium, found on the cob of corn ears. He sets forth a somewhat detailed description of the fungus and states that the fungus is not a parasite but only a saprophyte which covers the glumes and parts of the kernels, darkens them and can render the corn material slightly less valuable. He proposes the name *Coniosporium Gecevi* Bubak n. sp.

To be positively certain whether the species of Coniosporium, that is associated with our corn, is the same as Bubak had reported from Bulgaria, some specimens were sent to him on February 17, 1912, asking him to compare them with his native material. Similar specimens were also sent to Sydow and Lindau at Berlin and to Saccardo at Padua, Italy. These men were requested to identify the fungus sent, and also to state whether they regarded it as a parasite or a saprophyte.

During the following March replies were received from all four men. Lindau classes it in the genus Epicoccum and says: "It might be possible that this fungus grows first as a parasite and fruits as a saprohytic growth. However, investigation regarding this phase will elucidate."

[1]Einige interessante Pflanzenkrankheiten aus Bulgarien, Von Prof. Dr. Fr. Bubak (Tabor, Bohmen) und Dr. P. Kosaroff (Sofia, Bulgarien). (Referent Dr. Fr. Bubak.) Erster Teil. (Several interesting Plant Diseases from Bulgaria by Dr. Fr. Bubak (Tabor Bohemia) and Dr. P. Kosaroff (Sofia, Bulgaria). First part.) Centrb. f. Bakt. u Infekk. 31: 495-502, plates 2.

Sydow says, "I have found that it belongs to the genus Coniosporium, but I am unable to identify it with any known species so that I believe that it is a new species. I cannot decide the question whether the fungus is a parasite or only a saprophyte, but I am inclined to think that it is a saprophyte."

Bubak states that the fungus sent to him is identical with the one he has described. He sent some of his original specimens, of which the spore measurements and other characteristics agree well with our native material. He says in his letter: "I first received this fungus from Bulgaria in the winter and therefore could not decide with certainty whether it is a parasite or a saprohyte."

Saccardo in his reply states that the fungus is a new species of Coniosporium, but later corroborates the view held by Bubak. He makes no assertion regarding its parasitic or saprophytic nature. These statements show that it is not always an easy matter to decide whether a fungus organism is parasitic or saprophytic.

OBSERVATIONS MADE IN 1911

During the summer of 1911 cultures were made from the various tissues of the ear upon which the Coniosporium is found. These were developed at different intervals during the summer season until inoculations were made in August on a number of corn plants grown in the pathologist's garden. As a result the fungus was found on the check plants as well as those that had been inoculated. Because of too limited knowledge regarding the fungus no exact data could be obtained. Besides this, many unfavorable envi-onmental conditions, not anticipated, led to indeterminate results.

A number of days were spent during November and December examining the husked corn on the Station's fields in regard to this rot. Similar data were obtained from fields in the northwestern and southwestern parts of the State. The results of this work are summarized in Tables I and II. Some observations were also made on normal growing corn during the summer of 1911. No evidence could be obtained of the fungus as being associated, as a pathogenic organism, with the living corn plants. Yet but little assurance was placed in this, for very little was known regarding the nature of the fungus and how it behaves in the plant before it becomes conspicuous enough to be noted by the observer.

The first instance where the fungus was found was on ears of corn, the stalks of which had been cut about 2 weeks before. The tips of undeveloped ears were first affected and as the cob tissue lost its cell sap and the living processes of the cells ceased, the fungus would continue its growth into these parts.

Observations were made during November, December and on through April, 1912. In these observations the Coniosporium was found developed on the shanks, and infrequently some of the inner sheathing leaves of ears were covered with the mycelium and spores of the fungus. No other part of the corn plant could be found which was affected by the Coniosporium; and furthermore, no other species of plants associated with the corn were found affected by this fungus. It was assumed that Coniosporium might live on other plants during the spring and early summer months, which habit would help bridge it over until the corn is in a condition to be affected by it.

Only one specimen of another plant was found that was affected by Coniosporium, that being a head of barley which was dead and dry, having been eaten off by some insect. None could be found after a diligent search on the living barley plants. Here may be noted its saprophytic nature. During May and June a careful study was made of the young corn plants and of grasses and weeds growing with them. The only fungi found were *Pleospora* and *Epicoccum neglectum* on the the dead portions of clover leaves and on some of the dead portions of orchard grass and timothy. The Epicoccum also appears as a saprophyte on old, dead corn ears, leaves and stalks during the early spring after an abundant rainfall. It is of but little economic importance because it attacks those decaying parts which are of no practical value to the farmer.

In noting abnormal stages of young corn plants, the reddened condition, especially of those grown on clover or grass sod, was frequently observed. This, however, was generally due to the injury done by grubs, wire worms and other insects. The wounds serve as portals of entry for soil bacteria, which find their way into the vascular bundles, inhibiting the living processes of the plants and discolored, dwarfed plants are produced. Often, when the physical and biological conditions of the soil are unfavorable, the lower part of the stem of the young plant becomes affected with fungi and bacteria. These will affect the stem and roots and produce sick plants. The real causes for the abnormal conditions produced, subsequent to the dying off of the primary portion of the stem, are rather difficult to ascertain because of the many factors that enter in. All subsequent investigations were carried on in experimenting to determine whether the Coniosporium is a parasite or saprophyte.

METHODS OF WORK

The cultures were all grown on nutrient glucose agar in petri dishes. Fresh cultures were made continually in large quantities during the summer. During the hot weather of the

months of July and August only a few spores were developed by the fungus, but ample growth of mycelium was formed on the culture media. Later, however, the cultures were placed in the ice box, which furnished sufficient coolness for the development of spores on the mycelium. In cooler weather the mycelium grew profusely, forming an abundance of spores within a few days.

Sterile methods, that were best suited, were employed in making inoculations. All wounds were made with a sterile scalpel or needle on tissues that were sterile or had been made sterile by washing with bichloride of mercury. After the fungus had been inoculated into the tissue of the plant the wound was covered over by sterilized paper to keep out all organisms and to let only the inoculated organism be present in the tissue that was treated.

Besides the pure cultures on nutrient media, dilution cultures with distilled water were made and used; cob material affected with Coniosporium was also used. Inoculations were made from day to day when the weather permitted, and usually in the afternoon, when moisture conditions did not interfere with the inoculation process. All plants were labeled with tags dated and numbered consecutively.

Between July 30 and October 17, 1912, 276 inoculations of corn plants were made, laboratory numbers 1,056 to 1,331, inclusive, the work being done on 29 different dates and the inoculating material being placed in the nodes, internodes, roots, brace roots, sheath leaves, shanks, ears, silk and top leaves. Besides these, 40 to 50 inoculations were made on very young corn plants in greenhouse, garden and laboratory; 258 of these inoculations were made with Coniosporium cultures. These inoculations were examined at different dates until November, but no infections of Coniosporium were found from any of them.

On September 19th inoculations of 9 plants, Nos. 1251 to 1259, inclusive, were made of a mixed culture of two or more fungi that were found associated with decaying ears in last year's investigation of husked corn in the field. One fungus is a Diplodia and the other a dark colored organism, which with the Diplodia forms a grayish colored mass. The dark mycelium never has produced any fruiting bodies of any sort. It seems to live symbiotically with the Diplodia which I assume, from a limited knowledge of it, prepares conditions for the growth of the dark mycelial organism. The Diplodia, however, carries out the parasite's nature and brings about the results as found.

Examinations of the inoculated plants were begun on September 12 and contiuued until December, but no evidence was found of any infection by Coniosporium due to these inoculations.

On October 9th a somewhat superficial examination was made of the plants first inoculated with the Diplodia fungus. All nine ears of these plants at this time were beginning to show infection with the fungus. The inoculated ears were covered again with sterilized paper and were not examined again until in November. All the other corn plants, excluding the above nine, in this group, were inoculated with Coniosporium, but no infection took place.

The last examination of these plants was made on November 6th. The corn had at this time all been killed by freezing and the stalks had nearly dried out. The same ears on the plants, numbered from 1254 to 1259, inclusive, showed a good growth of the fungus inoculated in all parts of the ear. Some ears were more affected than others. At this time the white mycelium, apparently of Diplodia, covered considerable of the kernels. The early growth and action of the fungus on the kernels and cob is very similar to that of the Diplodia. Dark mycelial masses are produced that resemble very much the immature fruiting bodies of Diplodia. The dark, heavy-walled mycelium is very different from that of Diplodia. It seems that the Diplodia-like organism acts parasitically and after it has done its work this black colored fungus develops with it and grows as a saprophyte. The relationship of these two fungi appears somewhat complicated and involves a problem requiring further investigation.

LABORATORY EXPERIMENTS

One of the first experiments in this connection was carried on in the laboratory in the following manner: Growing ears of corn, in which all tissues were living, excepting a few portions of the sheathing leaves, were taken from healthy plants in the field. A certain number of these were placed in wire baskets and sterilized in the autoclave for one hour at 15 pounds steam pressure for two successive days. This was done to make sure that every particle of corn tissue was killed, and that nothing placed thereupon could grow or live as a parasitic organism. After their removal from the autoclave, under the best sterile conditions afforded, the ears were variously inoculated with fresh and pure cultures of Coniosporium. The inoculated specimens were then placed in large, sterilized battery jars, kept moist with sterilized filter paper; these in turn were covered with large sterilized bell jars. A sufficient amount of moisture was furnished by the sterile water poured upon the filter paper and into the bottom of the jars.

The same day similar inoculations were made on ears of living corn in the field and on ears brought into the laboratory, which were placed as checks in battery jars under bell jars without cooking.

After eight days the ears which had been cooked in the autoclave and subsequently inoculated with the pure cultures presented an abundant growth of mycelium and spores. The fungus had penetrated through the cob tissue, passing out and surrounding the kernels and filling up the cavities between the kernels and rows.

The living specimens under the bell jars, and those in the field which were inoculated the same day, showed no development on the living kernels and cob tissue, when also examined eight days after their inoculation. Plenty of moisture was present for the living and dead ears in both sets of experiments in the laboratory, a factor which was somewhat deficient with specimens in the field. However, this was not a general missing factor, inasmuch as the fungus did not develop on and in the living tissue when it had an abundance of moisture. Apparently the living protoplast of the kernels and cob tissue presents unfavorable conditions for the development of this fungus when placed there in its most active stage of growth. Numerous similar examples are also afforded by the inoculations made on the living tissues of the corn in the field during the summer. Examination and reexamination again and again showed that no infection had taken place in the live tissue; whereas, in the dead tissue, killed around the wound by the method of inoculation, there developed a good growth of the fungus. If enough moisture was present a good growth of mycelium would be produced on the tissue as it gradually died back from the wound. In this dead tissue, and especially in that of the cob, the fungus produced its normal amount of spores, which were viable and would again produce the fungus when placed on culture media.

Results quite similar to the preceding were also obtained by using last year's ears that had been naturally affected with the Coniosporium in the field. These were placed in a moist chamber, after washing off with bichloride of mercury (2 parts to 1,000 of water) some of the superficial spores of other fungi. After ten days or more the fungus had developed in the cob and about the kernels, giving the entire ear a somewhat grayish appearance, providing other fungi did not predominate in growth. However, it is very difficult to get a pure growth of Coniosporium under these conditions, because other forms, like Fusarium, Rhizopus, Penicillium, Aspergillus and Cephalothecium, will finally develop on the unsterilized material, thus making it difficult with so many of these other organisms to determine just how much Coniosporium would develop after having naturally become affected, and subsequently placed under these somewhat abnormal conditions.

Further evidence, showing that Coniosporium grows as a saprophyte, is deduced from the following experiment: Pure cultures of the fungus were placed on sterilized cellulose prepared from good filter paper. This had been digested with concentrated hydrochloric acid and subsequently washed free from the acid and sterilized in small Erlenmeyer flasks, from which it was poured into large petri dishes. Whenever the cellulose was too dry, sterile distilled water was added to make it loose as well as moist.

At ordinary room temperature, 16 to 18° C., the fungus started its growth quite readily and after 20 days the surface of the cellulose in the 100 mm. petri dishes was literally overgrown with the mycelium of the fungus. Later the mycelium penetrated through the entire mass of cellulose as well as covering the surface, which was black with spores.

With no other material than pure water and cellulose on which to develop, the readiness and length of time that Coniosporium will grow on this, certainly sets forth some evidence that it does not require living protoplasm in or on which to find the necessary nutriment for its development. Very few, if any, of the parasitic fungi can be made to develop to any great extent on pure water and cellulose alone. The fact that it can obtain food elements from these two compounds shows that it is not concerned at all during its living processes with living protoplasm or living cells to serve it as a host.

This fungus can easily be grown on other forms of cellulose. Pieces of pith, taken from the stems of elder and corn stalks, were placed in large test tubes with a small amount of distilled water. After sterilizing these in the autoclave the pith was inoculated with pure cultures of Coniosporium. A sufficient amount of water was left in the bottom of the tube to keep the pith moist. Growth of the fungus took place immediately and within eight days a great many of the pieces were penetrated and covered by the gray colored fungus. In this case it is clearly shown how the fungus affects the thin-walled parenchymatous cells, rather than the sclerenchyma cells that make up a part of the vascular bundles, the cortex of the corn stalk and a large portion of the hard material of the corn cob.

Furthermore, the readiness with which this fungus develops on the various culture media by transferring methods tends toward showing that this fungus presents no parasitic tendencies. Fungi that are known to be true obligate parasites are not easily changed in their nature from a parasite growing on living plants to a saprophyte growing on artificially prepared culture media. It was found that *Coniosporium Gecevi* developed on all the media that

were tried. It developed more readily and more luxuriantly on media that contained an abundance of grape sugar and some form of nitrogen. The following media, titrated to +1 to +1.5, were used and growth was obtained on all of them; nutrient glucose agar, corn meal agar, lima bean agar, plum decoction agar, Riedemeister's and Dr. Moore's synthetic media and sterilized wheat bread, besides the cellulose and pith already mentioned.

The fact that the Coniosporium grows so readily on some of the media and also that it grows on all the media, no special method or medium being required to make it grow as a saprophyte, is evidence of its saprophyte nature. On the other hand, obligate parasites, such as Rusts, Smuts, Helminthosporiums, and Peronosporas, are grown only with great difficulty on artificial media, because of the selective properties of the organisms and their obstinate nature in being changed to saprophytes. These obligate parasites affecting the corn plant have been found by investigators to offer many difficulties in growing them artificially.

Another experiment was performed with small corn plants growing in the greenhouse. The plants were from 10 to 15 days old, 3 to 4 inches high and growing vigorously, thus possessing a considerable amount of meristematic tissue which is frequently more susceptible to infection by fungus organisms. The soil covering the roots and lower part of the stem was removed, pure cultures of Coniosporium were abundantly applied, and the soil was replaced. These plants were in no way affected or inhibited in their growth when compared with the check plants growing along with them. A similar experiment was carried out on plants grown in the garden. No symptoms that the plants were being affected in any respect could be noted on any of these.

The results from these experiments further support the conclusion that the Coniosporium organism is not a parasite, but merely a saprophyte.

Besides the experimental work in the laboratory, greenhouse and garden plots, observations were made on the corn in various parts of the State and in local fields of farms adjoining the Station. Of the many thousands of corn plants thus observed and studied no plant was found where Coniosporium was active as a pathogenic organism. Again, if this organism had been the cause of serious disease heretofore, it is presumed that it would not have escaped the detection of mycologists and plant pathologists during the past years. It certainly could not have developed *de novo* or through some mutating process during the past few years.

Judging from the extent to which this fungus is found, it seems probable that it has been indigenous with the corn in this country and only the favorable weather conditions brought about its abundance in the crop of 1911.

ECONOMIC SIGNIFICANCE OF CONIOSPORIUM

Since this fungus, as ascertained from investigational evidence, cannot be considered as the cause of disease of the living corn plant, it has, nevertheless, an economic importance, for it does render the kernels less valuable, as do the mucors, penicillium, aspergillus and other similar forms. It is true that the mycelium penetrates the various cob tissues and the lower portion of the kernel, such as the funiculus. Besides the basal portion, it may cover over as much as the lower half of the kernel. But it cannot be maintained that Coniosporium injures the young plant or embroyo in the kernel. The conditions which are favorable for the development of the fungus have previously been unfavorable to the living processes in the young plant, which is dead before the fungus begins its saprophytic action on that portion of the kernel.

The injury done by the Coniosporium, aside from that done to the cob tissue, is relatively small, comparing ear with ear of those affected with other fungi which destroy the entire kernel and render its food content almost valueless.

In regard to its effect on the feeding value of the corn, farmers who fed their cattle with corn affected by Coniosporium claim that no abnormal effects could be noted on animals fed with such corn. Several farmers stated that they fattened stock on just such corn. It is difficult to have corn affected only with the Coniosporium, and when symptoms of disease in the animal did occur, it may have been brought about by other forms of fungi that are known to be the cause of diseases in animals to which corn is fed.

The effect of cob-rot on the ears of corn after maturity would appear analogous to certain timber-rot fungi which attack the heart or other portions of the tree trunk, while not attacking the living portions of the tree, although the heartwood be still enclosed within the cylinder of the living layer. The analogy here suggested is that the economic value of the corn attacked by cob-rot is impaired, and in even greater proportion than the economic value of the timber destroyed by timber-rots. While we can not call such timber-rots of pine, oak, etc., diseases of the living oak or pine trees, we recognize their economic significance as timber-rots. In a similar sense the cob-rot will continue to be recognized as an impairment of the matured corn ears whenever prevalent.

OTHER FUNGUS DISEASES OF CORN

A diseased condition of the corn was first noted about August 14th in the variety plots and later in the ensilage fields of the Station. The most apparent symptoms in the leaves are quite like those caused by the early stages of rust infections. At first the spots are quite small and about a millimeter in diameter. Later these may enlarge to circular spots a centimeter across and frequently several of the small spots merge and form one large spot. These regions in the leaf are quite translucent and when all the leaves are affected it gives the plant a somewhat mottled appearance when observed by transmitted light. Photographs of the affected leaves will hardly present the spots in a surface view that will set forth the actual and essential features. The spots will after a time become brown, dry and hard. The pressed specimens will show this. From the incomplete study made, it appears that the mesophyl of the leaf is most affected but the vascular system is quite resistant and therefore very few leaves were found collapsed from the lack of water. It is difficult to find the early stages of this infection. A microscopic examination will reveal spores of rust bacteria and large spherical bodies and swarm-spores of this fungus which Barrett calls *Physoderma zeae maydis*. It is still a question whether this fungus in its swarm-spore stage does the entire injury, for the many cultures, made from the diseased parts, revealed two kinds of bacteria, one forming a white colony and the other a yellow. No growth of the fungus was secured although about 300 plates of cultures were made on nutrient glucose agar. Inoculations were made with the two bacterial forms but no symptoms were obtained. I am of the opinion that the bacteria are only secondary intruders.

A considerable number of leaves were pressed and preserved in good condition but it is quite difficult to find many of the resting spores in the dry material. The best and only method for the study of this is with the fresh material.

This fungus trouble was reported by Barrett[2] at the Science Meeting held at Cleveland last December. The illustrative material displayed by him resembles the material I found. I sent him some specimens and regarding them he says: "As far as I am able to make out they bear the same organism as found here and that I described at the Cleveland meeting."

Although the symptoms of the disease are very conspicuous, yet little is known about the real cause as to how they are produced. Therefore, careful isolations and inoculations must be made before much can be definitely stated about it.

[2] *Physoderma zeae maydis* Shaw, in Illinois, by J. T. Barrett.

TABLE I: Fungi found at husking, Oct. 20-30, 1911, on corn of different varieties.

	Variety of corn	Total No. of ears per shock	No. affected with Coniosporium	Percent	No affected with Diplodia	Percent	No. affected with Fusarium	Per. cent	Total percent affected
1.	U. S. No. 78	186	46	24.7	0	0	1	0.6	25.3
2.	Funk's Yellow Dent	154	44	28.6	2	1.3	0	0	29.9
3.	" " "	141	44	31.2	0	0	0	0	31.2
4.	" " "	148	29	19.6	2	1.3	0	0	20.9
5.	Stickney's Flint	170	147	80.6	2	1.2	0	0	81.8
6.	" "	202	176	87.1	0	0	0	0	87 1
7.	" "	148	138	93.2	0	0	0	0	93.2
8.	Check Clarage	175	87	49.7	3	1.7	1	0.6	52.0
9.	" "	177	53	29 8	2	1.1	0	0	30 9
10.	Clarage x White Cap	204	69	33.8	3	1.5	0	0	35.3
11.	" " "	172	47	27 3	0	0	2	1.2	28 5
12.	Cranz's White Cap	153	78	50.9	0	0	0	0	50.9
13.	" " "	149	41	27.5	0	0	1	0 7	28.2
14.	Check Clarage	165	57	34.5	0	0	1	0.7	35.2
15.	Silver King	180	27	15.0	1	0.55	0	0	15.5
16.	" "	175	68	39.0	1	0.6	0	0	39 6
17.	Untested Seed	123	14	11.4	0	0	0	0	11.4
18.	" "	151	26	17.2	2	1.3	0	0	18 5
19.	" "	189	74	39.1	0	0	5	2.6	41.7
20.	Reid Zehring	164	33	20.1	0	0	0	0	20.1
21.	" "	154	39	25.3	0	0	0	0	25.3
22.	Strain No. 84	132	36	27.4	1	0.8	0	0	28.2
23.	" " 84	136	32	23.5	1	0.8	0	0	24.3
24.	" " 84	141	22	15.6	0	0	1	0.7	16.3
25.	" " 84	132	26	19.7	2	1.5	0	0	21.2
	Average			34 87		1.13		1.0	35.15

TABLE II. Fungi found at husking in November, 1911, on corn planted at different dates.

	Time of planting	Total No. of ears per shock	No. of Unaffected ears	Percent	No. affected with Coniosporium	Percent	No. affected with Diplodia	Percent	No. affected with Fusarium	Percent	Total percent affected
1.	April 29, 1911.	184	150	81 5	31	16.8	3	1 7	0	0.	18.5
2.	" " "	159	126	79.4	29	18.2	3	1 9	1	0.5	20.6
3.	" " "	141	109	77.4	30	21.2	0	...	2	1.4	22.6
4.	May 7, 1911	170	128	75.3	37	21.8	3	1.7	2	1.2	20.6
5.	" " "	181	148	81.8	33	18.2	0	0.	0	0.	18.2
6.	May 16, 1911	180	144	80.+	33	18.3	1	.55	2	1.1	18.96
7.	" " "	145	125	83.5	20	14.4	.	....	3	2.06	16.46
8.	May 26, 1911	143	129	83.3	22	15.3	2	1.4	.	....	16.7
9.	" " "	159	128	80.5	29	18.2	.	....	2	1.3	19.5
10.	June 6, 1911	158	131	83.0	26	16.4	1	.6	.	....	17.0
11.	" " "	135	100	74.1	35	25.9	.	....	.	....	25.9
12.	" " "	175	154	88.1	19	10.8	.	....	2	1.1	11.9

Table II gives the percentage of the different fungi found at husking on corn planted on different dates in 1911. No Coniosporium was found affecting the corn before or during the time of cutting. With the exception of Diplodia and Fusarium, all Coniosporium developed on the ears in the shock during the moist weather.

There were only 3 shocks of the different plantings, hence no larger number of observations could be obtained. But from the limited observations that could be made on the small field, the data

show that there is no difference in the total amounts of fungi occurring on the corn planted at different times in spring. The Coniosporium was found just as abundantly on the early as on the late plantings. The weather conditions are the chief factors in determining the amount of Coniosporium that will develop on ears of corn.

TABLE III: Fungi found at husking, Oct. 24 to Nov. 14, 1912 on corn of different varieties.

	Variety of corn	Total No. of ears per shock	No. affected with Coniosporium	Percent	No. affected with Diplodia	Percent	No. affected with Fusarium	Percent	Total percent affected
1.	Boone Co. White	130	1	.76	.	...	1	.76	1 5
2.	" " "	145	2	1.40	.	...	...	...	1 4
3.	" " "	152	..	.....	...	...	1	.6	.6
4.	" " "	136	..	.....	1	.7	...	...	.7
5.	" " "	131	..	.....	.	...	1	.76	.8
6.	" " "	111	..	.....	1	.9	.	....	.9
7.	Clarage	157	5	3 20	.	...	...	....	3.2
8.	"	140	3	2.10	.	...	1	.7	2.8
9.	"	141	4	2.80	.	...	3	2.1	4.9
10.	U. S. No. 182	154	..	.....	.	...	.	....	0.
11.	" " " "	126	..	.....	.	...	.	....	0.
12.	" " " "	148	..	.....	.	...	.	....	0.
13.	Cook's Original	145	..	.....	.	...	.	....	0.
14.	" "	138	..	.....	.	...	.	....	0.
15.	" "	132	..	.....	.	...	.	....	0.
16.	Cook's No. 75	187	9	4.80	.	...	1	.5	5.3
17.	Check Clarage	160	6	3.80	2	1.3	.	...	5 1
18.	Early Leaming (Frost)	181	10	5 50	.	...	5	2.7	8.2
19.	Early Leaming	180	31	10 70	1	.6	.	....	11.3
20.	Untested Seed	256	6	2.30	.	...	5	1.9	4.2
21.	" "	226	3	1.30	.	...	4	1.8	3 1
22.	" "	203	4	1 90	.	...	3	1.4	3 3
23.	" "	197	9	4.60	.	...	3	1.5	6.1
24.	Check Clarage	113	11	9 80	.	...	.	....	9 8
25.	" "	129	4	3.10	.	...	2	1.6	4.7
26.	" "	171	7	4.10	.	...	7	4.1	8 2
27.	" "	144	4	2.80	.	...	6	4.1	6.9
28.	" "	121	..	.....	.	...	1	.8	.8
29.	" "	110	8	7.30	.	...	2	1.8	9 1
30.	Tested Seed	180	7	3.90	1	.5+	4	2.2	6.6
31.	" "	181	6	3.30	.	...	1	.5+	3.8
32.	" "	52	12	23.00	.	...	2	3.8	26.8
33.	Untested Seed	55	5	9 09	.	...	4	7.2	16.29
34.	Dark Co. Mammoth	83	15	18.07	.	...	.	....	18.07
35.	" " "	90	14	15 50	.	...	2	2.2	17.7
36.	" " "	71	16	22.50	.	...	.	....	22 5
37.	Dark Co. Mammoth	81	10	12.30	2	2.5	.	....	14 8
38.	" " "	221	3	1.30	.	...	4	1.8	3.1
39.	Leaming	78	20	25.60	.	...	2	2.5	28 1
40.	"	195	10	5.20	.	...	3	1.5	6.6
41.	"	108	17	15.70	1	.9	2	1.8	18.4
42.	Clarage new	126	2	1.60	.	...	.	....	1.6
43.	" "	158	13	8.20	.	...	.	....	8.2
44.	" "	201	9	4.40	.	...	.	....	4 4
45.	" "	232	11	5.70	.	...	2	.8	6.5
46.	Clarage old (short ear)	132	10	7.60	.	...	.	....	7.6
47.	" " " "	201	6	2.90	.	...	5	2.4	5.3
48.	" " " "	156	9	5.70	.	...	2	1.3	7.0
49.	" " " "	223	16	7.20	.	...	9	4.0	11.2
50.	" " " "	187	6	3.20	.	...	2	1.0	4.2
51.	" " " "	230	8	3.50	.	...	6	2.6	6.1
52.	" " " "	151	14	9.20	.	...	.	....	9.2
53.	" " " "	182	14	7 60	1	.5	7	3 8	11.9
54.	" " " "	216	8	3.70	.	...	4	1.8	5 5
	Average			6.90		.98		2.07	7.79

The corn in shocks numbered 10-15 inclusive in Table III was very green when it was cut and contained considerable moisture in

the stalks and sheathing leaves, while all the cob tissue and kernels contained considerable cell sap. This greenness or presence of much living tissue accounts for the ears not being affected by any fungi. Not all the shocks of this variety were examined and there may have been some that were affected with Diplodia.

The percents of corn found affected with Coniosporium in 1912 range from 0 to 26.6, which is relatively lower than that of the crop of 1911, where the range found is 11.4 to 93.2 percent. The average of the total affected plants, as found in 1912, is 6.9 percent, while that of 1911 is 34.8 percent, showing that the crop was considerably more affected in 1911 than in 1912.

In Table III the data numbered from 32-37 were taken from husked shocks in a part of the field where grub worms had done considerable injury during the entire summer and the stalks, with partly developed ears, died very readily and the ears soon afforded enough dead tissues for the Coniosporium to begin its growth. Following this, on Nos. 38-54, the percents are somewhat lower, indicating a better and more normal growth of corn in the same rows of the field, but there was inhibition of growth, apparently by external factors.

SUMMARY

Of the many thousand living corn plants examined none were found that were injured or diseased with *Coniosporium Gecevi*.

Inoculation experiments were carried on from July 30th to October 15th, 1912, a period of 78 days, during which time all stages of corn plants were utilized for the many different methods of inoculations that were used to duplicate or carry out such as might occur under natural conditions.

No infections were obtained on the living corn plants from the 276 inoculations made in the field. Besides these the 40 to 50 inoculations made on very young corn in greenhouse, garden and laboratory presented no evidence of infections.

Eighteen inoculations, made with an unknown fungus or fungi (probably Diplodia and another organism), produced good infections and diseased ears. Further detailed data is needed on these organisms, before more definite statements can be made.

Field and laboratory tests indicate that *Coniosporium Gecevi* develops and acts as an obligate saprophyte, and therefore cannot be considered as the cause of a disease.

Coniosporium has an economic significance in that it destroys the cob tissue as a saprophyte; its effect on the kernels is rather limited when compared with the injury of Diplodia, Fusarium and other fungi.

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